United States Patent [19]

Jones

[11] **3,894,722**

[45] **July 15, 1975**

[54] **CONTINUOUS DRIVE LIQUID MIXING AMD METERING DEVICE**

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[52] **U.S. Cl.** ..... **259/22;** 23/252 R; 222/135; 239/142; 251/357; 259/7

[51] **Int. Cl.** **B01f 15/02;** B01f 7/14

[58] **Field of Search** ..... 222/135, 145; 259/7, 9, 259/10, 25, 26, DIG. 30, 8, 23, 24, 22; 141/99; 23/252 R; 137/DIG. 3; 251/357; 239/142

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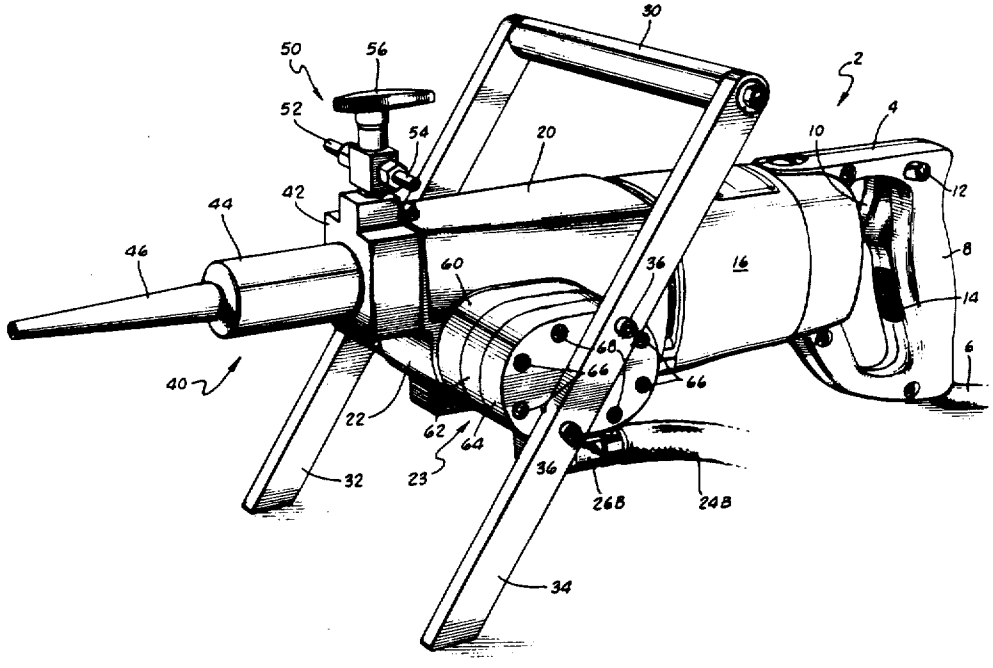
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Primary Examiner—Harvey C. Hornsby
Assistant Examiner—Philip R. Coe

[57] **ABSTRACT**

A device for mixing two or more substances in which each substance is metered by a separate continuous-flow, positive displacement, volumetric gear pump, then forced together in a mixer manifold, then mixed to homogeneity by forcing through rotating ball, roller, or cone bearings. As an added feature of the invention, the mixer has a purge system permitting one-way flow of either solvent materials or washing materials into the mixer manifold, and a clutch assembly which allows the pumps to be disabled and thus non-delivering while the mixer is being purged. Another feature is valving to permit the introduction of catalysts or the like into the mixer manifold.

14 Claims, 11 Drawing Figures



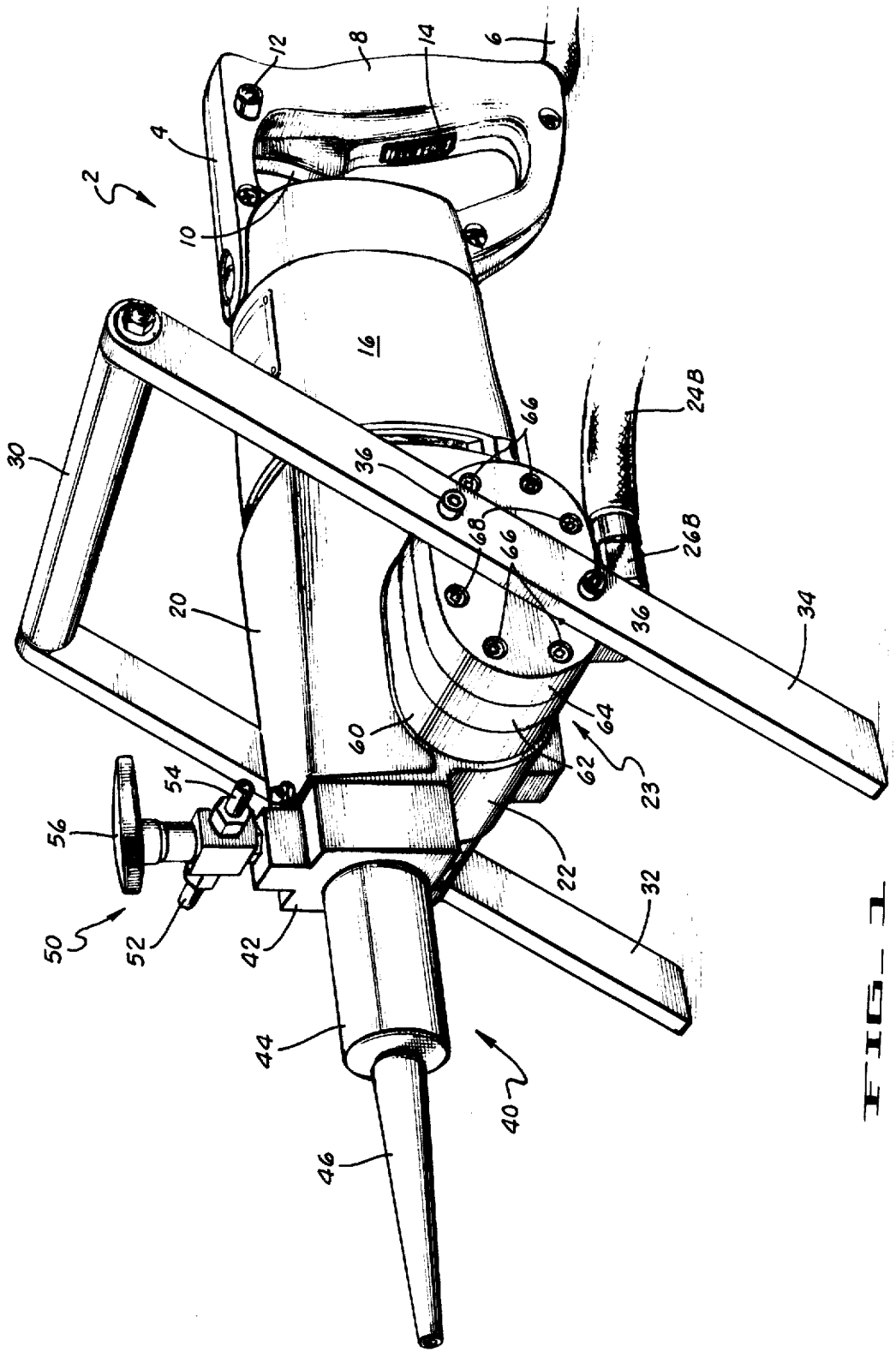

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24B
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FIG. 1

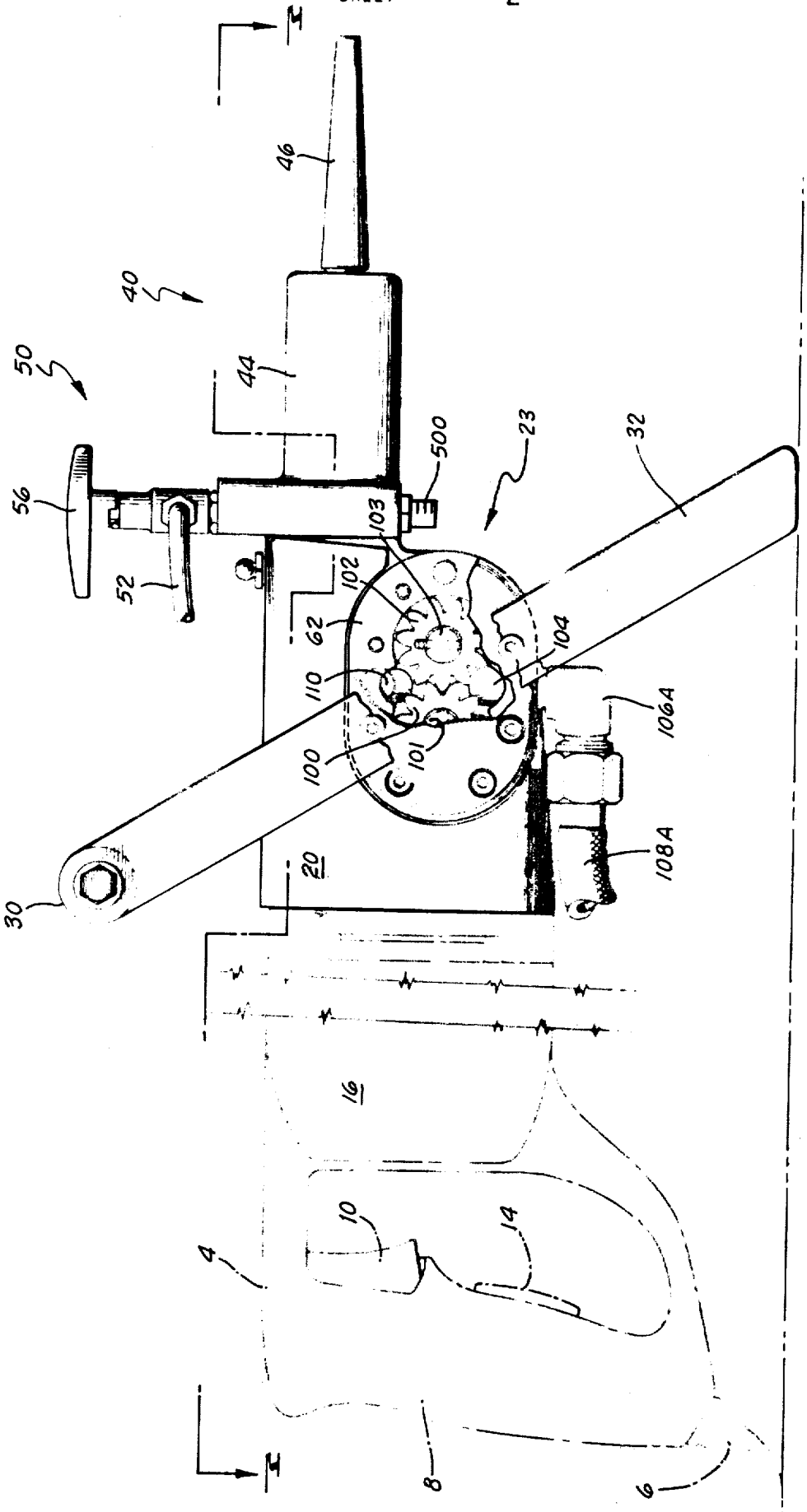

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FIG_2

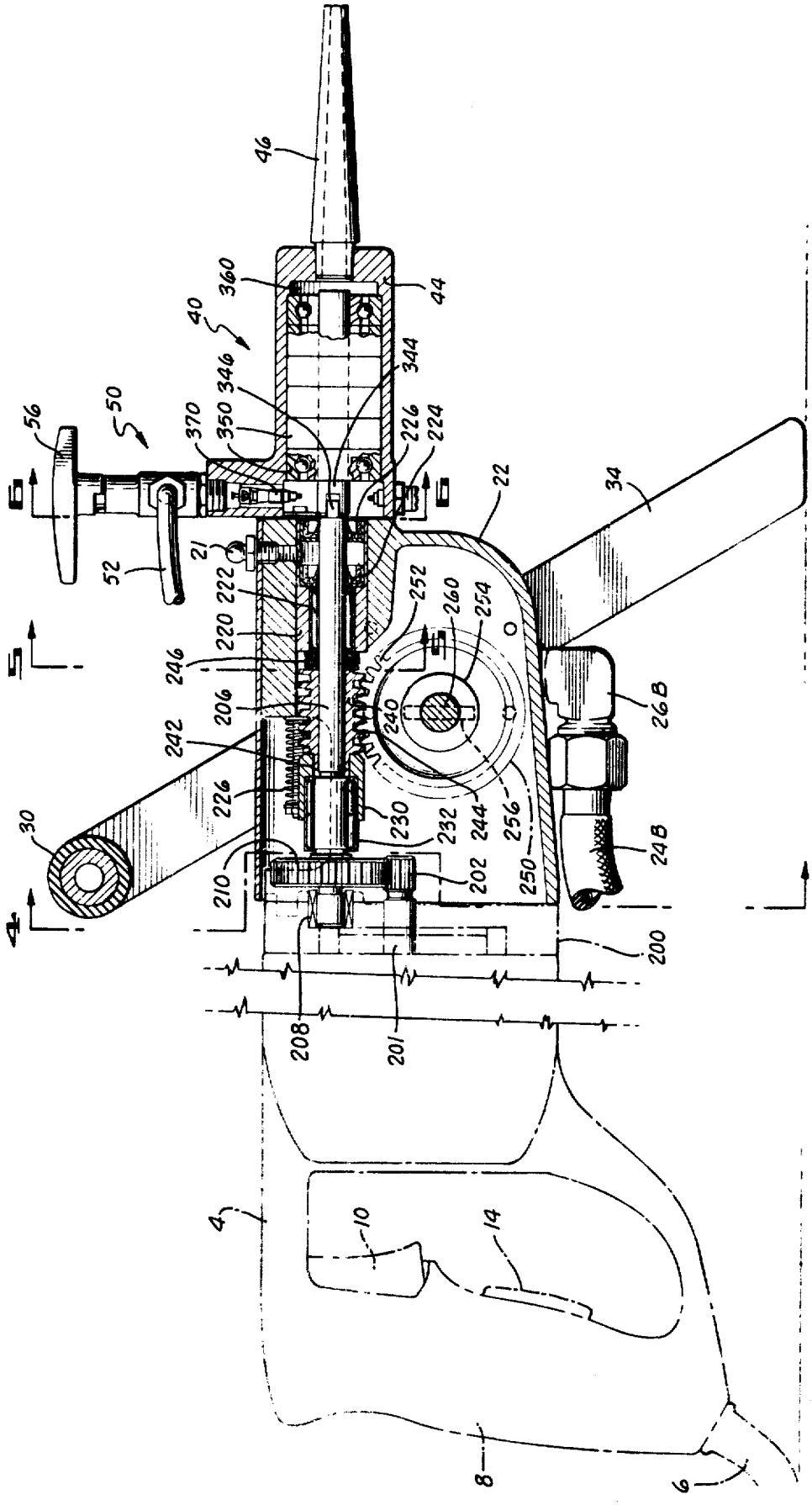

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346
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224
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222
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252
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254
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206
242
240
268
226
230
232
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256
248
30
210
202
250
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201
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6

FIG. 3

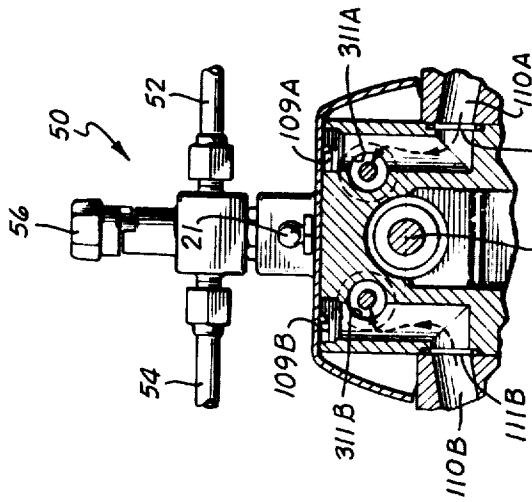


FIG-5

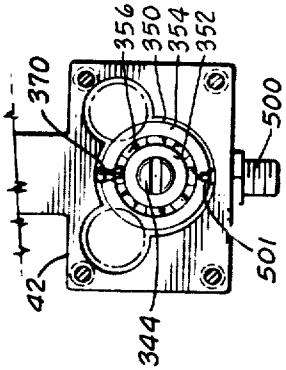


FIG-6

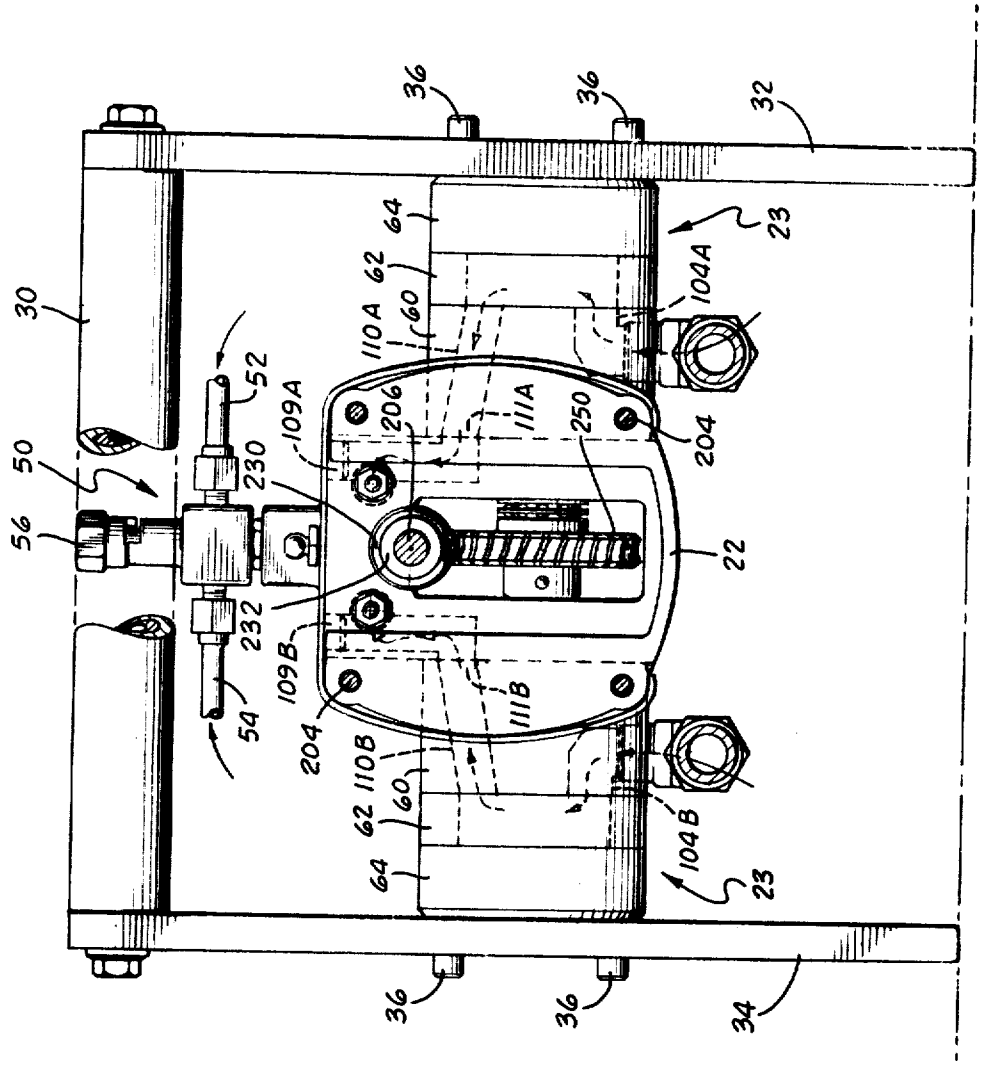


FIG-4

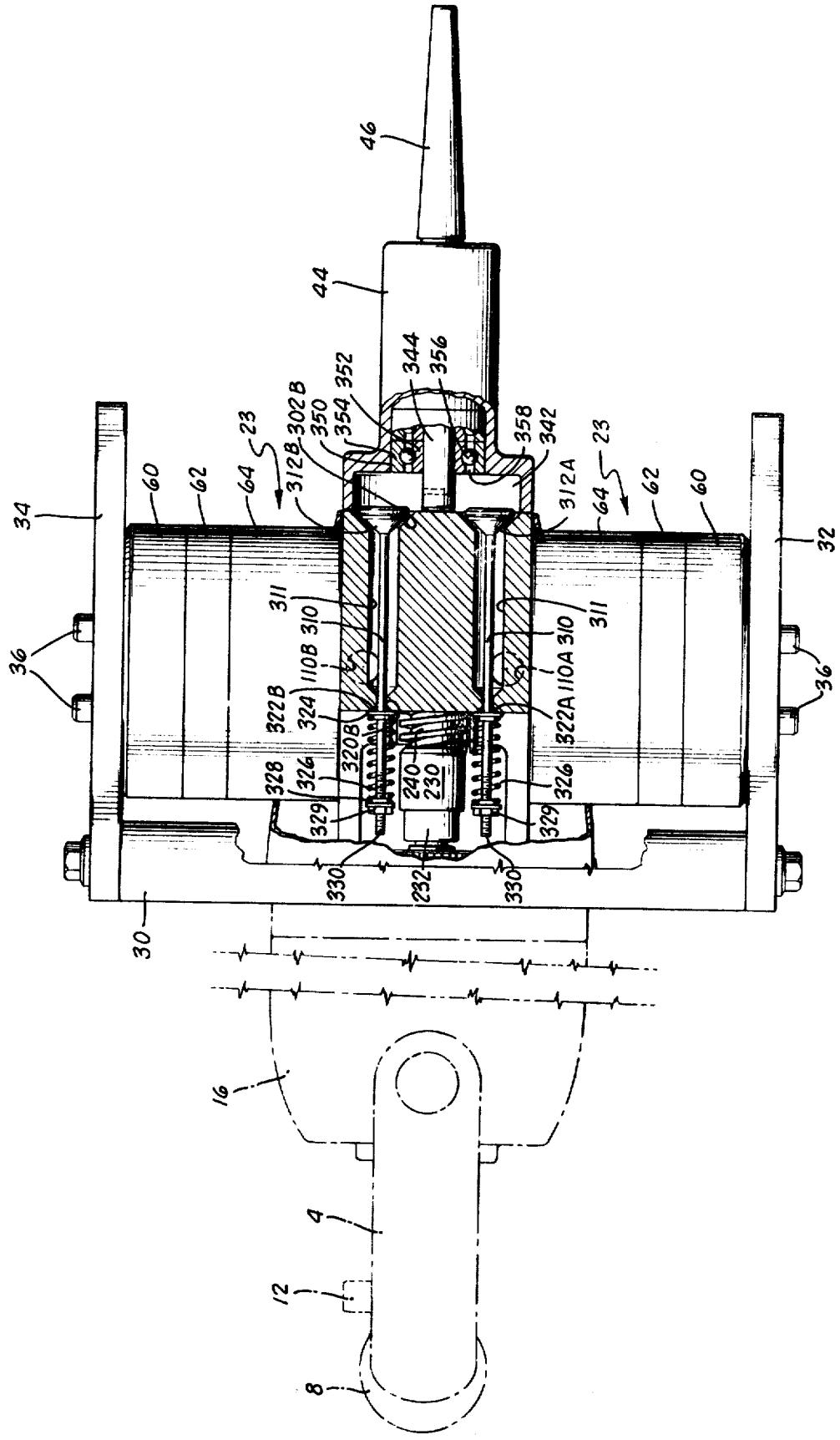

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44
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64
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311
310
110B
110A
322B
322A
324
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328
329
320B
240
230
330
232
312B
312A
302B
350
352
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344
356
358
342
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16
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12
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FIG. 2

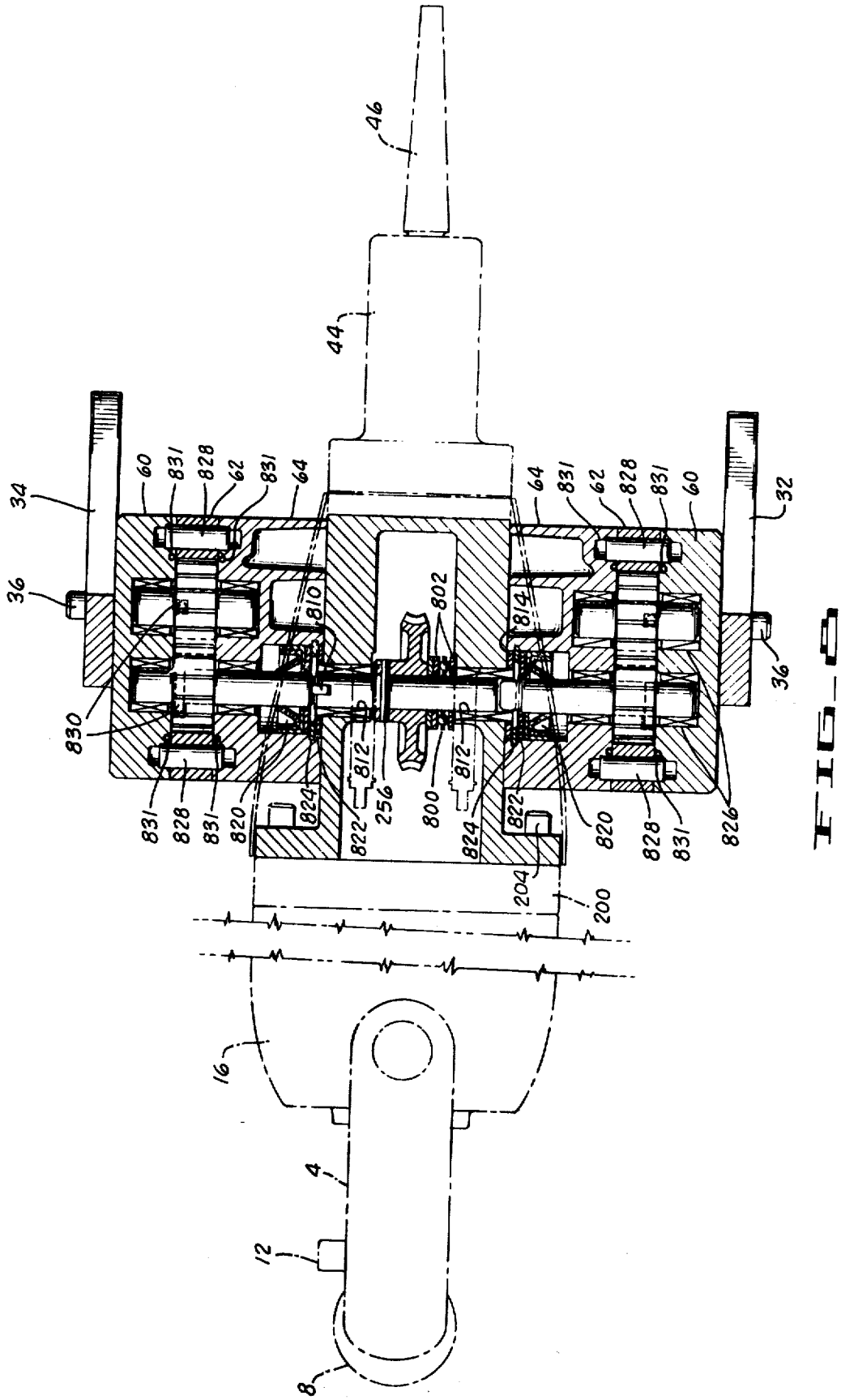

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36
810
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830
812
812
256
800
831
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831
820
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822
820
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204
200
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FIG. 6

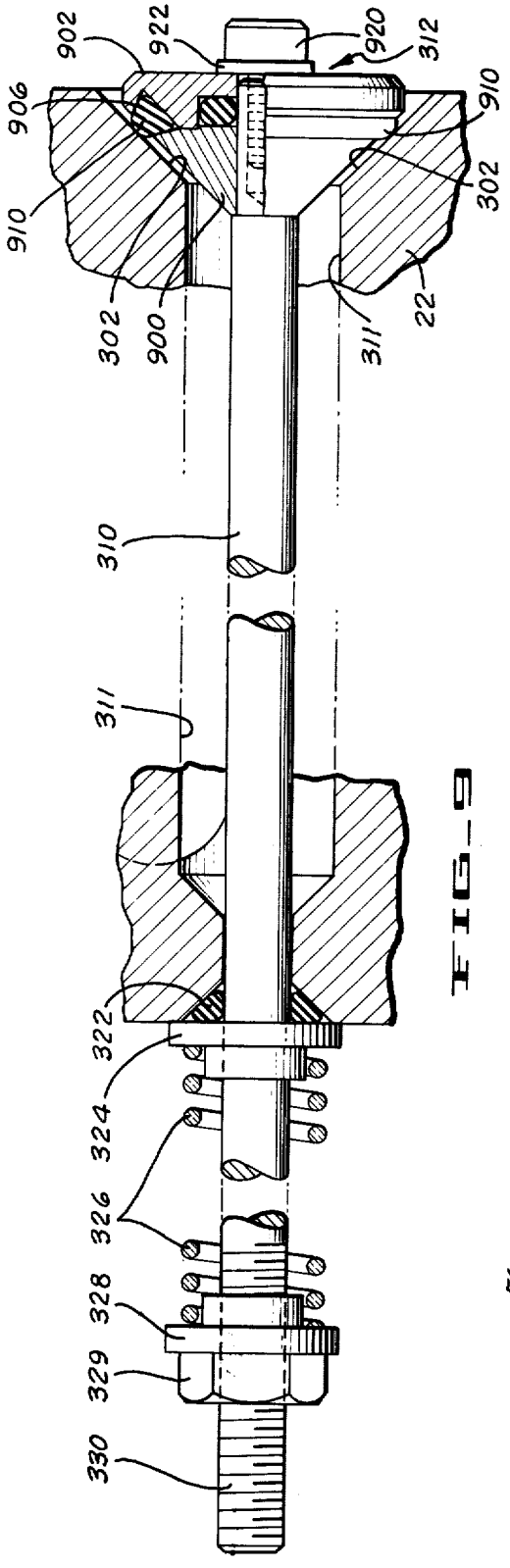


FIG_9

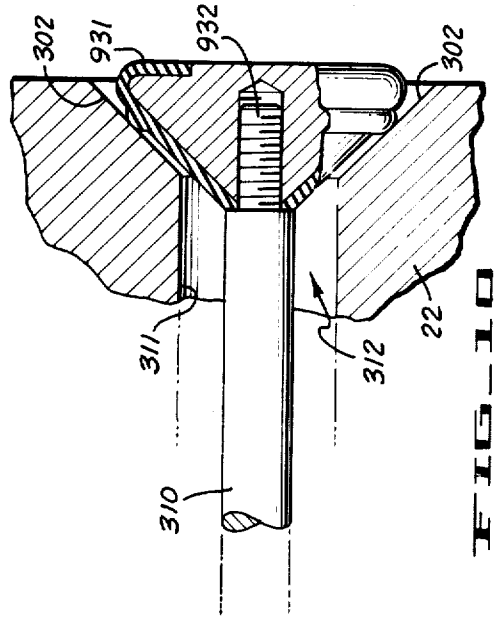


FIG_10

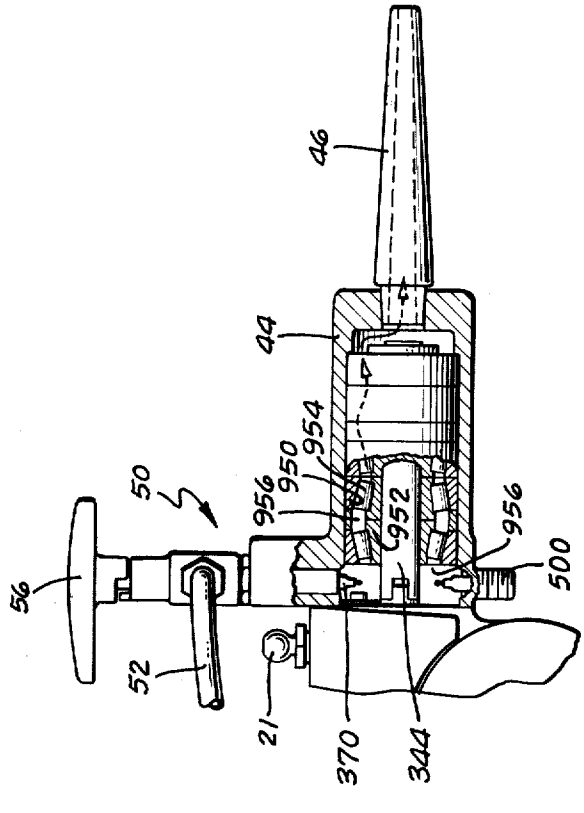


FIG_11

CONTINUOUS DRIVE LIQUID MIXING AMD METERING DEVICE

SUMMARY OF THE INVENTION

This invention relates to devices for mixing together materials which upon being united form highly viscous or solid substances, and more particularly the invention relates to a precision meter-mix-dispense system for Urethane foams, epoxies, resins, elastomers, and polysulfites, that is continuous-flow, very accurate, and simple to construct and operate.

Prior art dispensers for metering, mixing, and dispensing Urethane foam and the like have been mainly adaptations of paint spray machines, using pistons and constrictive values for pumping and metering each component. The length of the piston stroke or oriface determines the amount of each material injected into the mixer. This arrangement has resulted in very unreliable metering and maintenance of proper ratio, because the strokes per minute of each piston may vary or pressures may rise and drop. Obviously a piston device does not give a continuous flow of foam, but rather a pulsating stream of material.

There are even greater disadvantages: the piston dispensers are so complicated in their valving and controls that they require a two man technically oriented crew, one to hold the nozzle and another to continually adjust the guages, valves, and controls. They are also bulky and expensive, requiring large pumps, an air pressure source, and usually booms to hold the enormous weight of the mixer and dispensing nozzle.

Prior art mixers were enormously bulky in themselves — a typical weight being about 40 pounds. The mixers to date have been of the dynamic type, requiring a separate power source causing paddles, pins, or the like to agitate the two materials to be mixed, the ultrasonic type with associated electronics, and static mixers, which pass the two substances through a series of stators. So far, mixing effectiveness has been far from perfect, so that the foam or other material dispensed has had significant striations of unmixed components.

Another inadequacy in the prior art was the inflexibility of the pump/meter system. Once the pistons were built, the ratios between them were fixed for all practical purposes. If it were desired to mix and dispense two components in a new ratio, it was necessary to build an entirely new device. Similarly, the delivery rate of the old devices was completely non-variable.

In the Urethane and epoxy field, the most dominant factor is the set-up time of the material once the constituent components are brought into contact. Since many mixtures harden into solids that are impossible to dissolve, wash away, scrape off, or remove in any other manner, most meter/mix/dispense systems have had to use disposable mixers or have included a purge system which had the capability of dissolving and washing out the various substances very quickly. Most such purge systems, however, have had very short useful lives themselves because the Urethane or other material being dispensed would be pressured up into the purge valves, causing them to jam.

The "set-up time" problem can be so acute with some materials that no mechanical dispenser can even be used. For example, where cracks in a wall or on some other vertical surface are being epoxied the mix will sag away from the cavity to be filled unless it sets

up almost immediately. In some applications a set-up time as low as one second may be found.

It is, therefore, the general object of this invention to provide an improved meter/mix/dispenser system for Urethane foam and the like. One specific object of the invention is to provide a simple to use, compact, continuous flow dispenser that is accurate and reliable in maintaining the proper ratio between input components. On an intermittant or continuous demand basis and operable by non-technical personnel with minimal instruction.

Another object of this invention is to provide a mixer that leaves no striations in the output substance and yet is not as bulky and complex as present mixers.

Another object is to provide a meter/pump subsystem that can easily vary the ratio between thhe components being metered and can also vary the delivery rate of the final mixed product.

In the achievement of the above and other objects and as a feature of this invention there is provided a meter/mix/dispense system in which all components are driven from a common or an easily synchronizable power source or sources. In the preferred embodiment described below one power source drives a central shaft from which each pump/meter and the mixer as well derive their impetus. As another feature of the invention each pump/mixer is a gear pump driven by a common gear pump shaft which derives its rotary motion from a worm gear on the main drive shaft. By varying the chamber and gears of the pump, the volumetric output per rotation can be increased or decreased — a very simple operation, as the detailed description below will show. By alternating the machining worm gear set, i.e., single, double or four threads, mounted on the common shaft of the pump/meters, the rate of output of the dispenser can be varied without any danger of varying the ratio between pumps. Thus, the modular features of this invention achieves its object of easily-variable metering ratios and output rates.

Another feature of the invention is a mixer which combines the principles of dynamic mixers and static mixers by using free wheeling roller bearings—ball bearings, cone bearings, or rods—in the flow path of the mixed components. The high shear and milling action imparted to the pressurized fluids as they pass through has been found to achieve almost perfect mixing, in the short space of a half dozen or so bearings mounted in series and rotated by the central shaft of the dispenser. Of course, it should be pointed out that such a mixer could be actuated by a power source remote from the pump/meter subsystems or through a flexible shaft, without affecting either the ratio of components mixed or the output rate, so that actuation of the mixer by the common drive shaft is merely for purposes of economy, simplicity, and reduction of bulk and weight.

Another feature of the invention is the capability of introducing purge materials, blowout air, solvent, as well as a number of liquid and gaseous catalysts or other components with a system of valves that is not fouled and jammed by the high-pressure Urethane, as was previously the problem. This feature consists of mounting between the inlet valve for each purge liquid or gas a check valve which blocks all back-flow of Urethane, while opening easily to permit the introduction of fluids in the opposite direction.

Another feature of this invention is the creation of valve poppets in the line of flow of the components emerging from the various pump/meter subsystems that could maintain good sealing over long periods of time. The chemical nature of the substances involved together with their high pressure after they emerge from their respective pump/meters make ordinary O-rings useless for sealing purposes. Applicant, however, has achieved two alternative concepts either of which can maintain sealing indefinitely. One alternative is to assemble a two piece poppet which squeezes and traps an O-ring such that enough of the O-ring protrudes to perform sealing, but not enough to be torn away by the pressure. The second alternative is to mold a poppet face of Viton or the like, appropriately shaped to perform sealing. For certain materials a solid molded poppet of Teflon is required.

Other objects and features of this invention and a better understanding thereof may be had by referring to the accompanying drawings taken together with the detailed description and claims set forth below.

REFERENCE TO THE DRAWINGS

FIG. 1 is a perspective view of a preferred embodiment of Applicant's invention;

FIG. 2 is a side elevation in partial cutaway of the preferred embodiment of Applicant's invention of FIG. 1;

FIG. 3 is a side elevation in full cutaway of a preferred embodiment of Applicant's invention of FIG. 1;

FIG. 4 is a rear elevation in cutaway along the section lines 4—4 of FIG. 3;

FIG. 5 is a detail view in cutaway along the section lines 5—5 of FIG. 3;

FIG. 6 is a detail view in cutaway along the section lines 6—6 of FIG. 3;

FIG. 7 is a top view in partial cutaway of the preferred embodiment of Applicant's invention of FIG. 1;

FIG. 8 is a top view in full cutaway of the preferred embodiment of Applicant's invention of FIG. 1;

FIG. 9 is a detail view in partial section of a meter output valve according to Applicant's invention;

FIG. 10 is a detail section view of an improved poppet according to Applicant's invention; and

FIG. 11 is a side elevation in partial cutaway of the mixer assembly (including mixer, three way purge valve, purge check valve, and third component inlet provision and nozzle) of the preferred embodiment of Applicant's invention.

DETAILED DESCRIPTION

Referring to FIG. 1, the preferred embodiment of Applicant's invention shown therein comprises a power source to, which may be any prior art electrical, air, or other drive means. In the actual device built according to this detailed description, a Rockwell Manufacturing Company Model 757 electrical drive was used. This power source has a handle 4, an electrical cord 6, a grip 8, a trigger switch 10, a trigger lock 12, and a reverse switch 14. The controls 10, 12, and 14 operate an electrical motor 16 which is mounted upon the main body of the dispenser system.

The central works of the dispenser system, to be described in connection with later drawings, are covered by a body cowling 20 having a grease fitting 21 through which lubrication and a grease barrier between seals may be introduced. Underneath the body cowling 20 is a yoke assembly 22 upon which the gear pumps 23 are mounted. Each gear pump 23 in the preferred embodiment that was constructed was an Eastern Industries 2100 Series Fluid Motor.

By convention in the Urethane dispensing fluid, the right hand side of a dispenser is said to be the recipient of the "A" component of the Urethane foam. The left hand side handles the "B" component. Accordingly, at 24 B of FIG. 1 a component input hose leads to an input fitting 26B of the left hand gear pump 23. B component would be supplied through the input hose 24B by gravity, pump pressure or air pressure applied upstream at the storage container, all as is well known in the prior art.

The meter/mix/dispense system of FIG. 1 is carried and supported by a handle 30 and legs 32 and 34, which are affixed to the yoke assembly 22 by screws 36 which pass through the gear pumps 23. Forward of the yoke assembly 22 is a mixer assembly 40, including a mixer manifold housing 42 wherein the A component and the B component come together for the first time, the mixer 44 and an outlet nozzle 46. Mounted upon the mixer manifold housing 42 is a purge system 50 including an inlet 52 for solvents, an inlet 54 for blowing agents and or air, and a handle 56 for a three-way valve which can alternatively admit fluids from the inlet 52, admit fluids from the inlet 54, or permit no flow at all into the mixer manifold 42.

Referring still to FIG. 1 it can be seen there that each gear pump 23 is made up of three sections 60, 62, and 64; the inner section 60 nearest the yoke assembly 22 being referred to herein as the input or drive side, the middle section 62 being referred to herein as the center plate, and the outermost section 64 being referred to as the rear side. The three sections 60, 62, and 64 are assembled to the yoke assembly 22 by first stacking, then inserting pump assembly screws 66, and finally mounting the stack to the yoke assembly 22 with pump mounting screw 68.

Referring to FIG. 2, the partial cutaway of the A side gear pump 23 shown therein shows the inner works of the gear pump 23 as they would appear if the rear side plate 64 were not present. The center plate 62 is shown to have an inner cavity in which are fitted a drive gear 100 rotatable by a drive shaft 101 and a secondary gear 102 which rotates freely on a secondary shaft 103. The teeth of the drive gear 100 mesh with the teeth of the secondary gear 102 to transfer rotary motion from the drive shaft 101 thereto. A fluid to be pumped by the rotation of the gears 100 and 102 enters through an input port 104 at the end of input fitting 106 fed by an input hose 108 in the manner explained in connection with the hose 24 and fitting 26 of the B side in FIG. 1. The A component forced into the gear pump shown in FIG. 2 exits through an output port 110 into a valve in the yoke assembly 22 that will be described in connection with FIGS. 7, 9, and 10.

At this point in the Detailed Description several of the important features of Applicant's invention can be appreciated. The feature of accurate metering and continuous flow dispensing is achieved by driving separate components through the separate gear pumps 23 to be united under pressure in the mixer manifold 42. The very important feature of providing variability of the ratio of A component to B component is achieved simply by varying the thickness of the center plate 62 and matching gear sets 100 and 102 of one or both gear

pumps 23. Variation of the thickness of either center plate 62 and gear sets 100 and 102 carries with it a concomitant variation of the volume of the cavity within the center plate and of the gears 100 and 102. By selecting gears with larger or smaller tooth configurations, metering output and ratios can also be adjusted. This is a very important advantage when ratios of over 10 to 1 are required. Thus by supplying matched sets of center plates 62, gears 100 and 102, as well as screws 36, 66, and 68 and shafts 101 and 103, it is possible to give one dispenser according to this invention the capability of metering components in a variety of ratios.

In connection with FIG. 2 it can be seen that a dispenser according to the invention is small enough and simple enough to be carried and operated by a single person. Likewise the use of flexible, lengthy input hoses 108 and supply tubes as shown at 52 for the inputs to the purge system 50 permits the dispenser to be moved wherever desired, constituting a great improvement over the bulky, boom-suspension, two-man rigs available at the present time.

Referring to FIG. 3, the drive train of the dispenser begins at an armature output shaft 201 of the electric motor 16, or, of course, at the output shaft of any comparable power supply. The yoke assembly 22 has a power supply interface plate 200 through which the output shaft 201 protrudes, with a gear 202 mounted thereon. Four mounting screws 204 secure the yoke through the interface plate 200 to the power source. A main drive shaft 206 is mounted within the yoke assembly 22 with its rear bearing 208 mounted on the power supply interface plate 200. A reduction gear 210 mounted on the drive shaft 206 meshes with the output gear 202 to transmit power therefrom. The forward end of the drive shaft 206 culminates in a drive shaft cartridge 220 which includes a front bearing 222, and front and rear seals 224 and 226.

Riding on the main drive shaft 206 just forward of the reduction gear 210 is a clutch housing and tang 230 with clutch 232 engaging a worm 240, which rotates freely about the drive shaft 206. The worm 240 is coupled to the clutch housing and tang 230 by a worm tang 242, the overall effect being that power from the drive shaft 206 is transmitted to the worm 240 when the electrical motor 16 is in forward, while leaving the worm 240 free to rotate whenever the reverse switch 14 is activated to purge the mixer 44. The worm 240 has a certain length of worm threads 244 and a thrust bearing and washer assembly 246 which occupy between them the full length of the shaft 206 between the clutch housing 230 and the drive shaft cartridge 220. As another feature of this invention, the replacement of a worm 240 with another having a different number of threads 244, i.e., varying the worm pitch will vary the output rate of the dispenser, assuming that the power source 2 is of constant speed, in a manner to be described hereinafter.

Power from the worm 240 is transmitted to the gear pumps 23 through a drive train having as its next component a worm gear 250 with worm gear teeth 252, in the preferred embodiment actually constructed, 30 in number. A worm gear hub 254 is secured via a worm gear roll pin 256 to a central pump shaft 260 which, as will be described hereinafter, is directly connected to the drive shafts 101 of the gear pumps 23. Thus rotation imparted to the worm 240 via the clutch 232 is directly coupled to rotate the pump gears 100 and 102.

The drive shaft 206 not only powers the worm 240 but also is tanged at 346 to the stacked roller bearings 350 within the mixer 44, so that said roller bearings 350 rotate whenever the electric motor 16 is operated either in forward or in reverse. When the electric motor is operated in forward the gear pumps 23 also operate, forcing A and B components into the mixer manifold 42, through the bearings 350 into the output cavity 360 and thence out the nozzle 46. When the electric motor 16 is in reverse, no A and B component is pumped by the gear pumps 23, but the drive shaft 206 still rotates the bearings 350. In this mode, solvent from 52 and air grom 54 may be valved into the mixer manifold 42 to purge the mixer.

As stated in the Summary section of this specification, one feature of this invention is the ability to perform instant purging at any time with a valve system that is not fouled by the highpressure A and B component. This object has been achieved with great reliability and longevity by the employment of a purge check valve 370 between the three-way valve 52–54–56 and the mixer manifold 42.

Referring to FIG. 4 the rear view of the cut away yoke assembly 22 shows the paths of the input ports 104A and 104B and the output ports 110A and 110B. The ports originate in the outer face of each drive side 60. These outer faces, of course, form one boundary of the pressure chamber in which the gears 100 and 102 do their pumping. The ports 104 pass through the drive side to the input fittings 26 and 106. The ports 110 pass through the drive sides 60 to enter the yoke assembly 22 where they culminate in two valve chambers 311 to be described in greater detail below. Inasmuch as the ports 110 must be drilled in solid material of the yoke assembly 22, plugs 109 are used to close off the ends where the drill entered the material. To avoid leakage at the boundary between the drive sides 60 and the yoke assembly 22, O-rings 111A and 111B are employed. FIGS. 5 and 6 show the relationship between the output ports 110, the valve chambers 311, and the ball bearings 350 through which the A and B components flow on their way to being dispensed.

Referring to FIG. 7 the purpose of the A and B valves in the yoke assembly 22 is both to prevent the seepage of A and B component due to supply pressures when the gear pumps 23 are not creating pressure and to prevent purge material from backing into the gear pumps. Accordingly, high pressure A and B component from the output port 110 must pass through valve cavities 311A and B before reaching the inside 342 of the mixer manifold through orifices at the valve seats 302. The valves consist of a valve stem 310A and 310B, terminating in a poppet 312A and 312B which must interact with its respective valve seat 302 to form a perfect seal against high pressure flow from 110. The concepts whereby this sealing capability is achieved constitute additional features of this invention which will be discussed in detail in connection with FIGS. 9 and 10.

At its other end each stem 310 passes through a bearing 320 in the structure of the yoke 22. The bearing 320 is shaped to contain an O-ring 322 which seals the gear bearing and is held in place by a front spring locater 324. Beyond each bearing 320 A or B is a spring 326 A or B running between its respective front spring locater 324 and a rear spring locater 328 which is positioned by a tightening nut 329 screwed upon threads 330 at the rear end of the stem 310.

The strength of the spring **326** is chosen to ensure that the poppets **312** A and B will be held closed when the gear pumps **23** are not creating pressure, while, of course, permitting the poppets **312** to open when A or B component is being pumped from **23.** The nut **329** adjustment threads **330** combination permits the tension of the springs **326** to be increased or decreased very quickly and simply, depending upon the supply pressure associated with different A and B components. As a notable example, when the Polyol is employed on the B side in the dispensing of Urethane foam, a high supply pressure is necessary because of the high viscosity of Polyol. The supply pressure, as was explained in connection with FIGS. **1** and **2,** originates in or near the container from which the component is forced through the input hoses **24** or **108.** Thus in the operation of a dispenser, the supply pressure would not be cut off every time the motor **16** is put in reverse for the purge operation. When an unusually high supply of pressure is encountered, as with Polyol, the purge operation would be spoiled by partial opening of a poppet **312,** were it not for the capability at **329 – 330** for increasing closing force, i.e., tension of the spring **326** exerted against the rear spring locater **328** and nut **329** to exert a closing force on the stem **310).**

The plan view of FIG. **7** is also an appropriate place to describe in detail the mixer which is an important feature of this invention. A or B component emerging at **302** enters the mixer manifold interior **342** under very high pressure. The only path of escape is through a series of ball bearings **350,** each having an inner race **352** affixed to the mixer drive shaft **344.** Each outer race **354** is mounted directly to the mixer housing **44.** Between the inner races **352** and outer races **354** are the balls **356.** The high pressure A and B component traverses each ball bearing **350** via the annulus **358.** Since the mixer drive shaft **344** is tanged to the main drive shaft **206** at **346,** as described in connection with FIG. **3,** whenever the main drive shaft is rotating in the forward direction to cause the gear pumps **23** to create pressure, the mixer drive shaft **344** will rotate, and with it, the ball bearing inner races **352.** As the component is forced through each annulus **358,** the shear between the inner race **352** and the immobile outer race **354** together with the shear of the rotating balls **356** creates an extreme mixing and milling effect that results in a unified substance completely free of striation emerging from the nozzle **46.**

Referring to FIG. **11,** the mixer shown there is an alternative embodiment of the mixer-bearing concept using cone bearings having an outer race **950** and an inner race **952,** cones **954,** and annulus **956** through which the A and B component is forced. Although the ball bearings shown in FIG. **7** are more common, less expensive, and thus easier to procure for replacement purposes, the cone bearings actually supply a greater shear and turbulence, if this is desired for some special application. Roller bearings are an obvious extension of this concept.

Referring to FIG. **8,** the plan view shown there is cut away to reveal the inner works of the gear pumps **23.** The worm gear **240** and its shaft **260** (the central pump shaft described in connection with FIG. **3**) can be seen to be mounted within the yoke **22** with a thrust bearing **800** and thrust washers **802** to ensure proper centering of the gear **240** and take up thrust load. The central pump shaft **260** is mounted rotatably upon the yoke **222** by the use of two needle bearings **812,** and transmits rotary motion to the pump drive shafts **101** A and B via tangs **810.**

Each gear pump **23** is capable of exerting extremely high pressure emanating from the cavities within the center plates **62.** Accordingly, it is necessary that the mechanical coupling between the worm gear **240** and the drive gear **100** be well sealed somewhere along the axes of the shafts **101** and **260.** This is accomplished by the mounting of high pressure seals at **820** together with washers **814** and **822** and retainer ring **824.**

Further details observable in FIG. **8** include needle bearings **826** upon which the shafts **101** and **103** are mounted rotatably into the plates **60** and **64** and dowels **828** which keep the plates **60–62–64** in perfect alignment. Gear pins **830** passing through the gears **100** and **102** and their shafts **101** and **103** cause the gears to be affixed to the shafts. Pump O-rings **831** ensure sealing of plates **60–62–64.**

Referring to FIG. **9** the detailed view of the valve system described above in connection with FIG. **7** illustrates one new poppet-sealing concept that is a feature of this invention. The solid poppet **312** of the prior art is divided into an inner poppet **900** and an outer poppet **902** which are completely separate parts in order to permit the manufacture upon one or the other (here, the outer poppet **902**) of an O-ring dovetail **906** — a cavity shaped to trap an O-ring **910** sufficiently that it will not be ripped away by the high pressures created by the gear pumps **23.** In the preferred embodiment shown in FIG. **9,** the inner poppet **900** is integral with the shaft **310** and the outer poppet **902** is mounted upon the shaft **310,** after the fitting of the outer O-ring **910** and an inner O-ring **912,** by the emplacement of a poppet tightening screw **920** and lock washer **922** screwing into an internal tap **924** in the shaft **310.**

Referring to FIG. **10,** the poppet **312** shown therein is onepiece, and according to the invention has a molded face **930** of appropriate material, in the actual embodiment constructed—Viton. The molded face is appropriately shaped as at **931** to perform sealing against the face **302.** In the preferred practice of this particular poppet concept the poppet is screwed onto the shaft **310** by threads **932** that have been coated with epoxy just before threading. Alternatively, a bolt and lock washer could be used to hold the poppet **312** of FIG. **10** in place. For certain chemical materials being processed it would be advantageous to machine the complete poppet configuration **312** from a material such as Teflon, Nylon, or polypropolene, due to their non-reactive properties.

Referring to FIG. **6** again, another feature of Applicant's dispenser concept is an inlet fitting **500** mounted upon the mixer manifold **42,** to permit the introduction of a variety of fluids that might be necessary or advantageous into the mixture passing through the bearings **350.** In some applications, catalysts and accelerators would be passed in at **500.** In other cases, blowing agents would be introduced under pressure, Freon being the most-used. Such a blowing agent decreases the density of the dispensed mix and facilitates penetration of confined areas (e.g.-telephone coaxial cable). To prevent escape of high pressure "A" and "B" component, a check valve **501** protects the supply source upstream of the fitting **500.**

In the operation of the meter/mix/dispenser described above a single person can perform all tthe oper-

ations with one hand holding the grip **8** and another holding the handle **30** for exact positioning of the nozzle **46.** Since the features described above permit the construction of a dispenser weighing approximately **13** pounds, there is nothing slow, clumsy, or inaccurate associated with manipulating the dispenser without the aid of suspension booms or the like. The dispenser is flexibly connected to all its supply sources via the electrical cord **6,** the component hoses **24** and **108,** and such fluid tubing as is shown at **52.**

Thus prepared, the operator dispenses Urethane foam or the like by simply activating the trigger switch **10** to cause the electric motor **16** to rotate in the forward direction. As explained before, when the motor **16** operates in forward the main drive shaft **206** not only rotates the ball bearings **350** but also rotates the clutch **232** and and B the worm **240** to cause the gear pumps **23** to operate. Operation of the gear pumps **23** causes A ane1B component arriving at the fittings **26** and **106** to be pumped at high pressure out the output ports **110** into the manifold **42,** where they enter the mixer **44** and emerge as one substance to be dispensed out the nozzle **46.**

The purge operation, which is necessary whenever there is a moment's hesitation in dispensing, was in prior art devices performed by removing the mixer and washing it in solvent. The vast time saving permitted by Applicant's dispenser is shown by the simplicity of purging the mixer: the operator need only activate the reverse switch **14,** and then press the trigger **10** while switching the three-way handle **56** to introduce solvent **52** and then air **54** into the manifold **42,** from which it passes through the ball bearings **350** and out the nozzle **46.** This accomplishes thorough cleaning and the equipment is in readiness for its next use.

The following applications have been performed by dispensers built according to the principles of this invention without fouling the valves or the mixer, even with the very short set-up times ("pot-life") shown in some instances:

Formulator	Product Identification	Ratio A:B	Pot Life	End Product
Allied	Jet Seal " 9015	1:1	10 sec.	Joint Sealant
Thiokol	R 600 P	1:1	2 hrs.	Canal Sealant
Adhesive Engineering	Concresive "1219	1:1	15 min.	Inductive Wire Seal
Rezolin	164 Compound	2:1	4 hrs.	Cable Plugging
Reichhold	34 842 Polylite"	1:1.2	3 min.	Rigid Urethane Foam
API Systems	API 2200	84:16	30 sec.	Self Skinning Flexible Urethane Foam
3M Company	Scotchcast "Resin No. 8	48:52	33 min.	Electronic Potting
3M Company	PA 3532	1:1	3 sec.	Structural Adhesive

Thus it can be seen that Applicant has invented a highly flexible, easily-operated meter/mix/dispenser system which can utilize a single power source for all functions. In the alternative, the inventive concepts could be performed with separate power for the mixer **44,** especially if it is desired to have the mixer **44** and nozzle **46** remote from the gear pumps **23,** where space is confined. Similarly, two or more gear pumps **23** could meter equally well if they were operated by separate power sources but were synchronized or servoed to maintain accurate ratio.

The inventive dispenser can be employed with either an electrical power source as shown at **16** or an air drive power source. Using the Rockwell Manufacturing Company Model 757 electrical drive, the output of the armature **201,** 20,000 rpm, was reduced by a gear ratio of 11:47 between the gears **202** and **210.** The worm **240**/worm gear **250** sets utilized drove the gear pumps **23** at either 160 rpm, 320 rpm, or 640 rpm, depending on the dispense rate desired.

When an air drive unit is used at **16** the output shaft **201** rotates at about 10,000 rpm, reduced to 7,500 rpm by the gear **202, 210.** An air power supply has the advantage of greater horse power, about 3 H.P., as compared to 1 H.P. for the Model 757. Moreover, air power is an absolute necessity wherever explosionproof equipment is required by the work rules.

Although the various features of this invention have been described with a certain degree of particularity for purposes of illustration, it should be emphasized that the production to which Applicant is entitled extends to the full range of the inventive concept described in the claims below.

The inventive concepts for which protection is claimed are described as follows:

1. A multi-liquid metering and mixing dispenser for volumetrically metering a plurality of separate liquid components introduced into said dispenser through the plurality of separate input ports, then mixing together the metered volumes of said components, then dispensing the resulting mixture of said components, including:

a. a power source disposed for delivering power in a forward mode and a reverse mode;

b. a first metering means disposed for being driven by said power source and operatively associated with a first one of said separate input ports to receive a first said liquid component;

c. a second metering means disposed for being driven by said power source and operatively associated with a second one of said separate input ports to receive a second said liquid component;

d. said first metering means and said second metering means being operatively associated with said power source and with one another in such manner that the volumetric ratio of said first liquid component to said second liquid component remains fixed whenever said power source is driving said metering means;

e. mixing means operatively associated with said first metering means and said second metering means to receive said first liquid component and said second liquid component, said mixing means having the capability of intermixing said first liquid component and said second liquid component to form a substantially homogenous mix; and

f. means connected between said power source and said first and second metering means and said mixing means for driving said first and second metering means only in the forward mode of said power source and for driving said mixing means in both

the forward mode and the reverse mode of said power source.

2. The multi-liquid metering and mixing dispenser of claim 1 further including a manifold mounted between said first metering means and said second metering means and said mixing means, said manifold being adapted to receive said first liquid component and said second liquid component separately from said first metering means and said second metering means, respectively, and to pass said first liquid component and said second liquid component together into said mixing means.

3. The multi-liquid metering and mixing dispenser of claim 2, further comprising first protective means mounted between said first metering means and said manifold and adapted to prevent all fluid flow in either direction between said first metering means and said manifold whenever said first metering means is not operating, and second protective means mounted between said second metering means and said manifold and adapted to prevent all fluid flow in either direction between said second metering means and said manifold whenever said second metering means is not operating.

4. The multi-liquid metering and mixing dispenser of claim 1 with the following additional limitations:

a. a manifold mounted between said first metering means and second metering means and said mixing means, said manifold being adapted to receive said first liquid component and said second liquid component separately from said first metering means and said second metering means, respectively, and to pass said first liquid component and said second liquid component together into said mixing means; and

b. valve means mounted upon said manifold for introducing fluids into said manifold from sources other than said first liquid component and said second liquid component.

5. The multi-liquid metering and mixing dispenser of claim 4 with the following additional limitation:

a. a first protective means mounted between said manifold and said valve means and adapted to prevent all fluid back-flow from said manifold to said valve means while permitting free flow from said valve means to said manifold.

6. The multi-liquid metering and mixing dispenser of claim 4 with the following additional limitations:

a. a second protective means mounted between said first metering means and said manifold, and adapted to prevent all fluid flow in either direction between said first metering means and said manifold whenever said first metering means is not operating; and

b. a third protective means mounted between said second metering means and said manifold, and adapted to prevent all fluid flow in either direction between said second metering means and said manifold whenever said second metering means is not operating.

7. A multi-liquid metering and mixing dispenser for volumetrically metering a plurality of separate liquid components introduced into said dispenser through a plurality of separate input ports, then mixing together the metered volumes of said components, then dispensing the resulting mixture of said components, including:

a. a power source disposed for delivering power in a forward mode and a reverse mode;

b. a first gear pump disposed for being driven by said power source and coupled to a first one of said separate input ports to receive a first said liquid component;

c. a second gear pump disposed for being driven by said power source and coupled with a second one of said separate input ports to receive a second said liquid component;

said first gear pump and said second gear pump being mechanically connected to said power source in such manner that the volumetric ratio of said first liquid component to said second liquid component remains fixed whenever said power source is driving said gear pumps;

d. a mixer coupled to output ports of said first gear pump and said second gear pump to receive said first liquid component and said second liquid component, said mixer having the capability of intermixing said first liquid component and said second liquid component to form a substantially homogenious mix; and

e. means connected between said power source and said first gear pump, said second gear pump, and said mixer for driving said first gear pump and said second gear pump only in the forward mode of said power source and for driving said mixer in both the forward mode and the reverse mode of said power source.

8. The multi-liquid metering and mixing dispenser of claim 7 further including a manifold mounted between said first and second gear pumps and said mixer, said manifold being adapted to receive said first liquid component and said second liquid component separately from said first gear pump outlet port and said second gear pump outlet port, respectively, and to pass said first liquid component and said second liquid component together into said mixer.

9. The multi-liquid metering and mixing dispenser of claim 8 further including a first protective valve mounted between said first gear pump and said manifold and adapted to prevent all fluid flow in either direction between said first gear pump and said manifold whenever said first gear pump is not operating, and a second protective valve mounted between said first gear pump and said manifold and adapted to prevent all fluid flow in either direction between said second gear pump an said manifold whenever said second gear pump is not operating.

10. The multi-liquid metering and mixing dispenser of claim 7 with the following additional limitations:

a. a manifold mounted between said first and second gear pumps and said mixer, said manifold being adapted to receive said first liquid component and said second liquid component separately from said first gear pump outlet port and said second gear pump outlet port, respectively, and to pass said first liquid component and said second liquid component together into said mixer; and

b. a fluid introduction valve system mounted upon said manifold for introducing fluids into said manifold.

11. The multi-liquid metering and mixing dispenser of claim 10 with the following additional limitation:

a. a one-way flow valve mounted between said manifold and said fluid introduction valve system to prevent all back-flow from said manifold to said valve

system while permitting free flow from said valve system to said manifold.

12. The multi-liquid metering and mixing dispenser of claim **10** with the following additional limitations:

a. a first protective valve mounted between said first gear pump and said manifold, and adapted to prevent all fluid flow in either direction between said first gear pump and said manifold whenever said first gear pump is not operating; and

b. a second protective valve mounted between said second gear pump and said manifold, and adapted to prevent all fluid flow in either direction between said second gear pump and said manifold whenever said second gear pump is not operating.

13. The multi-liquid metering and mixing dispenser of claim **1** wherein the power source is directly coupled to said mixer and wherein said driving means includes a clutch and wherein said power source is coupled to said first gear pump and to said gear pump through said clutch which transmits power in one direction of rotation and does not transmit power in the opposite direction of rotation.

14. The multi-liquid metering and mixing dispenser of claim **1** wherein said power source is directly coupled to said mixing means and wherein said driving means includes a clutch and said power source is coupled to said first metering means and to said second metering means through said clutch which transmits power in one direction of rotation and does not transmit power in the opposite direction of rotation.

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